

REMARKS

Claims 1, 4, 5, 8-10 and 12 have been amended to place the claims in a form that better complies with U.S. Patent practice. Entry of this Amendment is respectfully requested, and claims 1, 4, 5, 8-10 and 12 are pending.

Statement of Substance of Interview

Applicants thank the Examiner for granting the personal interview of September 16, 2009, wherein the undersigned explained the distinguishing characteristics of the present invention, as compared to the cited prior art, and in particular, Eq. 1 and Fig. 1.

The Examiner requested that the claims be amended to place them in a form that better complies with US Patent Practice, the purpose of which is to place the claims in a format that makes them easier to read. The Examiner indicated that once the claim language was clarified, the application should be in condition for allowance.

Response to Objection to the Specification

The specification was objected to because it assertedly does not “contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same.” Applicants respectfully traverse.

(A) Regarding the use of the inlet mole ratio

In a NO_x removal apparatus, nitrogen oxide contained in an exhaust gas discharged from a boiler and having a temperature of about 350°C is subjected to NO_x removal treatment. Such nitrogen oxide is treated with ammonia (NH₃) serving as a reducing agent, in the presence of a catalyst in order to attain high efficiency of NO_x removal.

Ammonia is fed through a feed inlet disposed between a boiler and the inlet of a NO_x removal apparatus, in the form of gas or aqueous solution (in the case of a small-scale NO_x removal apparatus, aqueous urea solution is used instead of ammonia). The exhaust gas containing ammonia flows through the catalyst in the NO_x removal apparatus, whereby NO_x is decomposed to non-toxic nitrogen (N₂) and vapor (H₂O).

The amount of ammonia employed is modified in accordance with the NO_x concentration at the inlet of the NO_x removal apparatus (i.e., the outlet of the boiler), so as to attain target NO_x removal performance. Thus, for performance management of the NO_x removal apparatus, the exhaust gas passing through each NO_x removal catalyst is analyzed at the inlet and outlet of the catalyst.

In other words, the percent NO_x removal is controlled through management of the ratio of NH₃ concentration to NO_x concentration at the inlet of the apparatus:

$$\text{"inlet mole ratio"} = [(\text{inlet NH}_3 \text{ concentration})/(\text{inlet NO}_x \text{ concentration})].$$

The change in performance of an actual NO_x removal apparatus while the inlet mole ratio was varied was investigated. The results indicate that when the inlet mole ratio is increased (i.e., the amount of ammonia fed to the apparatus is increased), percent NO_x removal increases, whereas when the inlet mole ratio is decreased, percent NO_x removal decreases.

(B) Regarding Equation (1):

$$\eta = \frac{(\text{inlet NH}_3 - \text{outlet NH}_3)/(\text{inlet NH}_3 - \text{outlet NH}_3 + \text{outlet NO}_x) \times 100 \times (\text{evaluation mole ratio/inlet mole ratio})}{(1)}$$

As discussed above, in a NO_x removal system, NH_3 is gradually consumed in the course of the NO_x removal reaction. No NH_3 is generated inside the NO_x removal apparatus. Therefore, the outlet NH_3 concentration cannot exceed the inlet NH_3 concentration.

(C) Regarding the inlet amount of NH_3

Applicants disclose at page 8, last paragraph, “that the present invention employs an NO_x removal catalyst management unit for use with an NO_x removal apparatus, which management unit comprises NO_x measurement means for determining NO_x concentrations on the inlet and outlet sides of respective NO_x removal catalyst layers; NH_3 measurement means for determining NH_3 concentrations on the inlet and outlet sides of the same NO_x removal catalyst layers; and percent NO_x removal determination means for determining percent NO_x removal (η) on the basis of an inlet mole ratio (i.e., inlet NH_3 /inlet NO_x).

In addition, Fig. 1 represents a NO_x removal apparatus, comprising a NO_x removal catalyst management unit 20 provided with gas sampling means 15A through 15E on the inlet and outlet sides of respective NO_x removal catalyst layers 14A through 14D.

Thus, the specification makes it clear to one skilled in the art that the inlet amount of NH_3 to a catalyst layer corresponds to the outlet amount of NH_3 in the outlet of the previous catalyst layer. In other words, the inlet NH_3 concentration of the first catalyst layer represents the concentration (amount) of NH_3 fed before introduction to the NO_x removal catalyst. Further, the inlet NH_3 concentration of each subsequent catalyst layers represents the outlet NH_3 concentration of the corresponding upstream catalyst layer. The concentration of NH_3 in the ambient air is irrelevant.

(D) Regarding to outlet amount of NO_x

Generally, NO_x generated from boilers of a thermal power station and other plants is virtually in the form of NO (i.e., the NO_x to be treated by a NO_x removal apparatus is NO)

Since NO reacts with NH₃ at a ratio of 1 : 1, [(inlet NH₃) - (outlet NH₃)] (numerator) represents the concentration of NH₃ reacted, which is equivalent to the concentration of NO reacted.

Meanwhile, the denominator [(inlet NH₃) - (outlet NH₃) + (outlet NO_x)] is equal to the inlet NO_x concentration. Accordingly, percent NO_x removal can be calculated from the measurements of inlet NH₃ concentration, outlet NH₃ concentration, and outlet NO_x concentration.

(E) Inlet mole ratio and evaluation mole ratio

The “inlet mole ratio” is discussed above.

The performance of each of the catalysts layers employed in a NO_x removal apparatus is gradually deteriorated by fuel and exhaust gas components.

According to the presently claimed invention, the performance of each catalyst layer is correctly and objectively evaluated from data obtained from an analysis of the exhaust gas from each layer. When the catalyst layers are analyzed in terms of exhaust gas concentrations, the inlet NH₃ concentrations (mole ratios) of the catalyst layers vary, leading to variation in catalyst performance. In addition, the inlet mole ratio depends on the performance of the upstream catalyst layer.

In such a situation, in order to correctly and objectively assess the performance which each catalyst layer per se exhibits, percent NO_x removal of each catalyst layer must be determined at a common inlet mole ratio. In other words, percent NO_x removal values are compared with one another under identical conditions. According, a specific evaluation mole ratio is selected, and percent NO_x removal is calculated using the selected evaluation mole ratio (e.g., the time (year)-related change in the thus-calculated percent NO_x removal is investigated).

Thus, the specification does “contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same.” Accordingly, withdrawal of the rejection is respectfully requested.

Response to Claim Rejections Under § 112

Claims 1, 4-5, 8-10 and 12 are rejected under 35 U.S.C. § 112, first paragraph, because the specification was said to not reasonably enable the equation based on an inlet mole ratio.

Claims 1, 4-5, 8-10 and 12 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite

Applicants respectfully traverse.

For the reasons discussed above, with regard to the objection to the specification, claims 1, 4-5, 8-10 and 12 meet all of the requirements of § 112. Accordingly, withdrawal of the foregoing rejections is respectfully requested.

Claim Rejections Under § 103

(A) Claims 1, 4-5 and 10 are rejected under 35 U.S.C. § 103(a) as being unpatentable over JP-747108 to Keizo et al.

(B) Claims 8-9 and 12 are rejected under 35 U.S.C. 103(a) as being unpatentable over Keizo in view of U.S. Patent Application Publication No. 2002/0127153 to Ganeshan et al.

Applicants respond as follows.

The present claims are directed to a NO_x removal catalyst management unit and a method for managing a NO_x removal catalyst, comprising, *inter alia*, a percent NO_x removal determination means for determining percent NO_x removal (η) on the basis of an inlet mole ratio (i.e., inlet NH₃/inlet NO_x), which percent NO_x removal (η) is determined on the basis of the following equation (1):

$$\eta = \underbrace{\frac{(\text{inlet NH}_3 - \text{outlet NH}_3)}{(\text{inlet NH}_3 - \text{outlet NH}_3 + \text{outlet NO}_x)}}_{A} \times 100 \times \underbrace{\frac{\text{evaluation mole ratio}}{\text{inlet mole ratio}}}_{B} \quad (1)$$

The diagram shows equation (1) with three labels: 'A' is a bracket under the first fraction, 'B' is a bracket under the second fraction, and 'C' is an arrow pointing to the '100' multiplier.

Above formula (1) of the present invention has a portion (A) (left side), a portion (B) (right side) and a part (C) {the portion (A) + a part of the portion (B)(inlet mole ratio)}

In the present invention, the amount of NO_x removed by a NO_x removal catalyst layer is considered to be equivalent to the amount of NH₃ consumed during NO_x removal. Thus, inlet NH₃ and outlet NH₃ are measured. The amount of NO_x introduced to the catalyst (inlet NO_x) can

be represented by the sum of "outlet NO_x " and "the amount of consumed NH_3 ," and the amount of NO_x (inlet NO_x - outlet NO_x) can be represented by "the amount of consumed NH_3 ." Therefore, percent NO_x removal is represented by a ratio of "the amount of consumed NH_3 " to the sum of "outlet NO_x " and "the amount of consumed NH_3 ."

In other words, according to the present invention, inlet NH_3 and outlet NH_3 , which are not measured in conventional NO_x removal processes, are measured, and the measured values are employed instead of measurements of inlet NO_x and outlet NO_x . Thus, percent NO_x removal is calculated by formula (1) employing "the amount of consumed NH_3 ."

Keizo discloses that the percent NO_x removal of a catalyst layer is conventionally determined on the basis of measurements of inlet NO_x and outlet NO_x of a relevant catalyst layer, i.e., according to Keizo, percent NO_x removal is determined by the following formula:

$$(\text{inlet } \text{NO}_x - \text{outlet } \text{NO}_x) / (\text{inlet } \text{NO}_x)$$

According to the method of Keizo, wherein the NO_x concentration and unreacted NH_3 concentration of each catalyst layer are determined, and percent NO_x removal and percent contribution of each catalyst layer are calculated from the determined NO_x concentration, performance-deteriorated catalysts are replaced with new catalysts in order of degree of deterioration. In this regard, when the catalytic performance is evaluated by the percent contribution calculated on the basis of the NO_x concentration, the catalyst layer(s) having actually deteriorated performance cannot be detected correctly.

Regarding part (C) of presently claimed Formula (1), part (C) is obtained by dividing part (A) by the “inlet mole ratio.” By taking the “inlet mole ratio” into account, the NO_x removal performance of a catalyst can be evaluated on the basis of a percent NO_x removal of the catalyst in its actual state.

Neither Keizo nor Ganeshan discloses or suggests part (C) of formula (1).

Formula (1) of the present invention also includes an evaluation mole ratio in addition to part (C). In the case where the evaluation mole ratio is equal to the inlet mole ratio; i.e., in the case where the value of portion B of equation (1) is 1, percent NO removal (η) is expressed by portion A of equation (1). However, neither Keizo nor Ganeshan discloses or suggests portion A of Formula (1).

Thus, Keizo and Ganeshan fail to render obvious the present claims. Accordingly, withdrawal of the rejection is respectfully requested.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



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